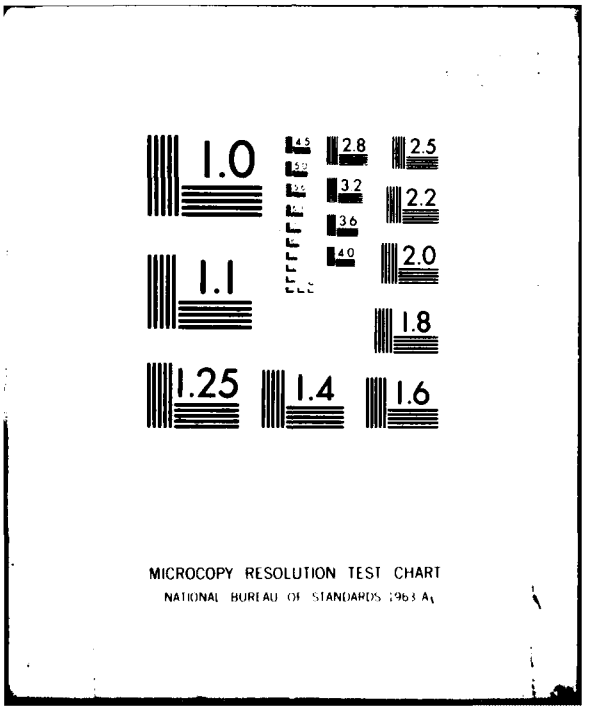
AD-A107 387 COLUMBIA UNIV NEW YORK F/G 13/9
AN INTEGRATED APPROACH TO THE OPTIMIZATION OF HIGH-SPEED CAM-FO--ETC(U)
SEP 81 F FREUDENSTEIN DAAG29-80-C-0135
UNCLASSIFIED ARO-12953.7-E NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963 A

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) ARO 12953.7-E and 15911.2-E

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FINAL TECHNICAL REPORT
2. GOVT ACCESSION NO.: AD-A107 387
3. RECIPIENT'S CATALOG NUMBER:
4. TITLE (and Subtitle): An integrated approach to the optimization of High-Speed Cam-Follower Systems.
5. TYPE OF REPORT & PERIOD COVERED: Final Technical Report. 8/1/78-7/31/81
6. PERFORMING ORG. REPORT NUMBER:
7. AUTHOR(s): Ferdinand Freudenstein
8. CONTRACT OR GRANT NUMBER(s): DAAG29-78-G-0176, DAAG29-80-C-0135
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Columbia University, New York, N.Y. 10027
10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS:
11. CONTROLLING OFFICE NAME AND ADDRESS: U. S. Army Research Office, Post Office Box 12211, Research Triangle Park, NC 27709
12. REPORT DATE: Sept. 15, 1981
13. NUMBER OF PAGES: 2
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office):
15. SECURITY CLASS. (of this report): Unclassified
15a. DECLASSIFICATION/DOWNGRADING SCHEDULE:

LEVEL II

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

DTIC ELECTE NOV 16 1981 S H D

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

NA

18. SUPPLEMENTARY NOTES

The view, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

High-speed mechanisms; cam-follower systems; dynamics; machine elements;

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Research has resulted in basic measurements on the dynamic response of a modern, high-speed cam-follower systems; the development of a predictive dynamic model for the dynamic response of high-speed cam-follower systems, both for normal behavior and the onset of toss, bounce and spring surges; and the application of optimal-control theory to the optimization of cam-follower systems in the design stage.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AD A107387

DTIC FILE COPY

TITLE

An integrated approach to the optimization
of high-speed cam-follower systems

TYPE OF REPORT (TECHNICAL, FINAL, ETC.)

AUTHOR (S)

F. Freudenstein

DATE

September 15, 1981

U. S. ARMY RESEARCH OFFICE

P.O. Box 12211
Research Triangle Park, N.C. 27709

CONTRACT/ GRANT NUMBER

DAAG 29-78-G-0176
DAAG 80-C-0135

INSTITUTION

The Trustees of Columbia University
in the City of New York,
Box 20, Low Library
New York, N.Y. 10027

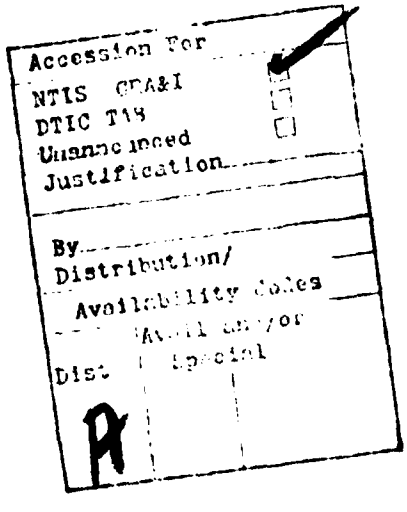
FINAL TECHNICAL REPORT

Grants: DAAG29-78-G-0176
DAAG29-80-C-0135

"An Integrated Approach To The Optimization
Of High-Speed Cam-Follower Systems"

Period Covered: August 1, 1978 - July 31, 1981

Report prepared by: Ferdinand Freudenstein
Principal Investigator



1. The problem

This research was concerned with three aspects of an integrated approach to the design of high-speed cam-follower systems.

The first was the gathering of experimental data and measurements on a modern, high-speed cam-follower system--in this case a current Pontiac four-cylinder engine.

The second was the development and verification of a predictive dynamic model for high-speed cam-follower systems.

And the third was the application of optimal-control theory to the optimization of high-speed cam-follower systems in the design stage.

2. Results

The objectives of the research with regard to the above three problems have been achieved.

With regard to the first problem, the research had been motivated in part by a lack of experimental data on high-speed cam-follower systems in the published literature. In planning for the measurements considerable instrumentation was developed and made specifically for this purpose and measurements at both low and high speeds covered a wide range of system performance. We were particularly encouraged, by the scope and quality of what we believe to be pioneering experimental data and measurements on a modern high-speed cam-follower system. When published this date should represent a frame of reference for research investigators in the field of high-speed cam design for the foreseeable future.

The experimental data has also been essential in the formulation and verification of a predictive dynamic model of high-speed cam-follower systems. The key to the development of the model was the combination of basic measurements of system response, the modeling of the return spring as a distributed-parameter system and the accurate determination of system damping characteristics. The model thus involves the solution of a system of ordinary differential equations coupled to a partial differential equation. It possesses the capability of predicting the performance not only of well behaved systems, but also--and more significantly--the onset of pathological behavior, such as toss, valve bounce and spring surges. This accomplishment realizes a basic requirement for the development of ultra-high speed cam-follower systems, including military equipment.

The optimization phase of this research project focused on the application of optimal-control theory to the determination of optimum values of system performance parameters. This included the analysis of non-linear models and the investigation of two-dimensional parameters, such as pressure angles and curvatures.

Eventually a balanced optimization procedure was developed, which achieves control both of cam-follower contact stress and residual vibrations.

3. Publications

1. "Optimization of high-speed cam-follower systems using optimal control theory." Ph.D dissertation of Meng-Sang Chew, Depart-

ment of Mechanical Engineering, Columbia University, July 1980; available from University Microfilms, Ann Arbor, Michigan.

2. "The analytic development and experimental verification of a high-speed cam-follower system," doctoral dissertation of Albert Pisano, Department of Mechanical Engineering, Columbia University, June 1981, 282 pp; available from University Microfilms, Ann Arbor, Michigan.

Note: Approximately four journal articles are in preparation for presentation at the 1982 ASME Mechanisms Conference in Washington, D.C.

4. Participating Scientific Personnel

Prof. Ferdinand Freudenstein (Principal Investigator)
Prof. Richard W. Longman (Senior Investigator) - (Control Theory)
Mr. Meng-Sang Chew (Graduate Research Assistant)
Mr. Albert Pisano (Graduate Research Assistant).

5. Advanced degrees earned on project

Dr. Meng-Sang Chew: Ph.D. in Mechanical Engineering, July 1980 (now with General Motors Research Laboratories, Warren, Michigan).
Dr. Albert Pisano: Ph.D. in Mechanical Engineering, June 1981 (now with Xerox Corporation, Tarrytown, New York).


DATE
ILMED
8